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## DOC 2008-02 Revision of Quantitative Reasoning Competencies

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## PROPOSAL TO THE ACADEMIC SENATE

**Title:** Revision of Quantitative Reasoning Competencies

**Submitted By:** Department of Mathematics

**Date:** January 23, 2009

**Action:** Legislative Authority

**Reference:** Art. II. B. 2.

**See also** [DOC 99-8](#), [DOC 00-10A](#), [DOC 00-10B](#), and [DOC 03-01](#)

### DESCRIPTION OF PROPOSAL:

On October 13, 2000, the Academic Senate passed documents 00-10A and 00-10B which detailed, respectively, the content of the Quantitative Reasoning Competencies (QRC) and an implementation plan and schedule. On January 17, 2003, the Academic Senate passed document 03-01, which replaced the module on exponential growth with one on mathematical models and made slight changes in the probability and statistics module. Since five years have passed, the Committee on General Education and Competencies reviewed the QRC policy to determine whether the competencies still meet the needs of the students at the University of Dayton.

Below we propose a number of changes to the General Quantitative Reasoning Competencies and their implementation. The new proposal eliminates the three modules approach and replaces it with two alternative tracks towards mathematics competency. Every student will take one of the two tracks, but no student is required to take both tracks. One track, the Analysis Track, expands the material covered previously in Module 1 to include both calculus and algebraic techniques and also incorporates mathematical modeling from Module 3. This competency is delivered through existing classes. This track is most appropriate for those students in programs that require an intensive study of mathematics which normally covers some form of calculus. The second track, the Descriptive Statistics Track, covers the material from Module 2 and also incorporates mathematical modeling from Module 3. This track is most appropriate for those students in programs that do not require advanced mathematics. It will help prepare them for a world in which an understanding of statistics is increasingly important. A student will now satisfy the General Quantitative Reasoning Competencies by completing either the Analysis Track or the Descriptive Statistics Track. This is done by passing an approved mathematics class with a grade of C- or better. This puts the Quantitative Reasoning Competencies on the same footing as the competencies for English and Communication which are also delivered through classes. Students are given a choice between calculus and statistics because we recognize that mastery of both skills is not necessary to be educated in a mathematical outlook and way of thinking. We recommend no change in the Graduation Quantitative Reasoning Requirements which are determined at the department and unit level.

## **Rationale**

The original motivation for the Quantitative Reasoning Competencies, as given in Senate Document 00-10A, is the following:

A quantitatively literate college graduate should be able to

- interpret mathematical models, such as formulas, graphs, tables and schematics and draw inferences from them
- represent mathematical information symbolically, visually, numerically, and verbally
- employ commonly useful mathematical and statistical methods to solve problems
- estimate and check answers to mathematical problems in order to determine reasonableness, identify alternatives, and select the most useful results
- recognize that mathematical and statistical methods have limits

The original and revised QRC documents proposed to deliver these skills through three modules. Module 1 covers algebraic methods; Module 2 covers probabilistic and statistical methods; and Module 3 covers mathematical models. Module 1 is essentially an unarticulated entrance requirement—a measure of what students know upon entering the university rather than what they have learned as a university student. It does not advance a student’s knowledge of or skills in quantitative reasoning beyond the level of first- or second-year high school mathematics. The Department of Mathematics did not choose to develop a course to cover this material or include it in existing courses. Consequently, an online test was developed which students had to pass in order to satisfy Module 1. The fact that Module 1 cannot be satisfied in a class proved problematic in its implementation and has caused great confusion among students and their advisors. The material in the other two modules was already covered in existing courses; however, the math department developed an online test for Module 2 so that a student who does not achieve a grade of C- or better in class can pass an online test rather than retake the course.

The competencies listed in Module 1 do not add significantly to the mathematical education of students at the University of Dayton or to their preparation for life after college. We also believe that competencies are best delivered through classes, rather than through online tests. Keeping track of the students who have not passed the tests has proved difficult, and persuading some of these students to take the Module 1 test even more so. For these reasons we propose that the current version of Module 1 be dropped and that the three module system for QRC be replaced by a new two-track model. We further recommend that all online testing be eliminated.

## **Revised General Quantitative Reasoning Competencies**

At the college level, a student should build upon the algebra and geometry experience of high school to further develop the mathematical knowledge necessary to support that student’s academic pursuits, enhance that student’s professional opportunities, and generally improve that student’s quality of life. This furthered mathematical knowledge is the substance of the quantitative reasoning competencies. The term “quantitative” is essential because computation is an integral part of mathematics. The term “reasoning” is essential because quantification alone significantly limits the power of mathematics. College graduates should be proficient at

recognizing and applying mathematical concepts inside and outside the contexts of classroom mathematics.

Under this revised plan, the General Quantitative Reasoning Competencies are partitioned into two tracks. Every student will take one of the two tracks, but no student is required to take both tracks. The description of each track below lists the competencies that each graduate of the University of Dayton should master and the manner in which demonstration of competency is to be accomplished.

### **Analysis Track**

Mathematics is sometimes called the language of science and technology, and algebra and calculus are the most common languages of mathematics. The analytic approach to problem solving is basic in science and is very important in economics. Students majoring in science or in an area related to business would be well served by a course which covers these competencies. This track sets a standard for the minimal expectations with respect to analytic quantitative reasoning competencies.

The competencies are:

- A student can analytically manipulate mathematical equations and functions using the techniques of algebra or calculus.
- A student can use the techniques of algebra or calculus to sketch the graph of a mathematical function or equation.
- A student can interpret the slope of a function as a rate of change.
- A student can find the extreme value of a function.
- A student can competently employ techniques of algebra or calculus in problem-solving exercises.
- A student understands how hypotheses and reasoning can create a process that leads to a mathematical model (problem-solving algorithm, equation, etc.).
- A student understands how different hypotheses and different reasoning processes lead to different models (problem-solving algorithms, equations, etc.).
- A student can employ a mathematical language to represent a problem in a mathematical framework.
- A student can relate a problem-solving algorithm and solution to the original problem and can determine if the mathematical model is useful.
- A student can extend or adapt a problem-solving algorithm to apply to a new problem.
- A student can employ a mathematical model to make meaningful predictions.
- A student recognizes reasoning and proof as essential parts of mathematics.

Completing the Analysis Track:

- A student will pass with a grade of C- or better any of the courses MTH 129, MTH 137, MTH 138, MTH 148, MTH 149, MTH 168, MTH 169, MTH 218 or
- A student will pass with a grade of C- or better any course that is transferred to the University of Dayton as equivalent to one of the above listed courses, or
- A student will have earned EM credit for MTH 168.

Rationale: These courses cover in detail the skills and knowledge needed to master the competencies of the Analysis Track.

### **Descriptive Statistics Track**

High-speed computers provide access to large amounts of data. Daily interaction with quantification in the form of data and analysis of data has become routine for individuals in today's society. Descriptive statistics provides an intellectual understanding of the framework in which data are collected and organized so that individuals can evaluate them and extract useful information.

The competencies are:

- A student can competently infer appropriate information when the data are given in a visual or graphical form such as a bar graph or a pie chart.
- A student can competently communicate appropriate information by constructing relevant visual or graphical forms of representing data.
- A student can competently calculate the standard measures of center: sample mean, sample median or sample mode.
- A student can make appropriate interpretations with respect to the standard measures of center.
- A student understands that there is a distinction between a sample mean and a population mean.
- A student can competently calculate the standard measures of spread: sample variance and sample standard deviation.
- A student can make appropriate interpretations with respect to the standard measures of spread.
- Using tables or otherwise, a student can competently compute probabilities for a random variable having a normal distribution with known mean and standard deviation.
- A student understands how hypotheses and reasoning can create a process that leads to a mathematical model (problem-solving algorithm, equation, etc.).
- A student understands how different hypotheses and different reasoning processes lead to different models (problem-solving algorithms, equations, etc.).
- A student can employ a mathematical language to represent a problem in a mathematical framework.
- A student can relate a problem-solving algorithm and solution to the original problem and can determine if the mathematical model is useful.
- A student can extend or adapt a problem-solving algorithm to apply to a new problem.
- A student can employ a mathematical model to make meaningful predictions.
- A student recognizes reasoning and proof as essential parts of mathematics.

Completing the Descriptive Statistics Track:

- A student will pass one of the following courses with a grade of C- or better: MTH 114, MTH 205, MTH 207, or

- A student will pass with a grade of C- or better any course that is transferred to the University of Dayton as equivalent to one of the above listed courses, or
- A student will have earned EM credit for MTH 207

Rationale: These courses cover in detail the skills and knowledge needed to master the competencies of the Descriptive Statistics Track.

### **Recommendations**

#### **Recommendation 1:** Demonstration of General Quantitative Reasoning Competencies

- That satisfactory completion of either the Analysis Track or the Descriptive Statistics Track described above in Revised General Quantitative Reasoning Competencies becomes a General Education requirement.
- That all students, including transfer students, in a timely fashion, be required to demonstrate mastery of the competency requirements for one of the two tracks in the manner detailed above in Revised General Quantitative Reasoning Competencies.

#### **Recommendation 2:** Graduation Quantitative Reasoning Requirements

- That the Graduation Quantitative Reasoning Requirements remain the same as given in Senate Document I-03-01: that each degree program should identify and assess appropriate graduation quantitative reasoning competencies that develop the quantitative reasoning abilities of its majors in a manner suitable for that field of study. If appropriate, these graduation quantitative reasoning competencies can go beyond the general competency level. Development of graduation competencies should emerge from guidelines and recommendations set forth in the Basic Skills Subcommittee Report, from discussions within each department and program, from consultation with the Department of Mathematics, and, when appropriate, from external standards established by professional organizations, domain specific learned societies, and accrediting bodies.

#### **Recommendation 3:** Implementation

- That the General Quantitative Reasoning Competencies will become operational in the fall of 2009.
- That students who entered the University of Dayton under the General Quantitative Reasoning Competencies defined in Senate Documents 00-10A, 00-10B, and 03-01 be allowed to choose either that system or the one outlined in this document as a method for satisfying the General Quantitative Reasoning Competencies.
- That the General Education and Competencies Committee, in consultation with the Department of Mathematics, will decide which courses satisfy the General Quantitative Reasoning Competencies.
- That these Quantitative Reasoning Competencies and implementation strategies are covered by the previously approved Governance Document (Senate Document 99-8).